



ArcReader® Map Creation for the **Distribution of Floodplain Management Information**

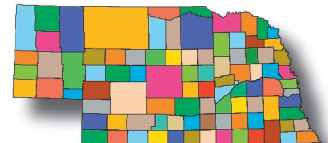
*Ryan Jester**

EXECUTIVE SUMMARY



The **Nebraska** Department of Natural Resources has created user-friendly, interactive, Geographic Information System (GIS) maps for **all 93 counties in Nebraska**. They are distributed on CD at no cost or in exchange for a blank CD.

The purpose of these maps is to distribute floodplain maps and information to local officials and others interested in floodplain management. The maps contain base data layers including aerial photographs, topographic maps, and vector data including roads, streams, sections and the county boundary. The maps can be viewed with a free software program called ArcReader®, which may be obtained at www.ESRI.com or by calling **1-800-447-9778**.



Maps of Nebraska, in CD format, may be obtained by calling **402-471-2363** or by emailing fpintern1@dnr.state.ne.us.

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INTRODUCTION

Geographic Information System

The Nebraska Department of Natural Resources (NDNR) uses ESRI's Geographic Information System (GIS) software for floodplain management and mapping. GIS is used to display geographic information, which can be linked to information such as flood insurance rate map (FIRM) panel numbers and dates, flood elevations, etc. Vector data in the form of shapefiles is created and used with ArcGIS™ software. The vector data includes roads, streams, Public Land Survey System information and flood elevations or depths (where available). In addition, image files (such as .jpg, .tiff, etc.) are also available for viewing within the software. This data can be displayed graphically within several GIS mapping software programs including ArcMap 8.x™. The map document that the software program creates can be used to compile the features in a way that can make data analysis and computations easy for users to perform.

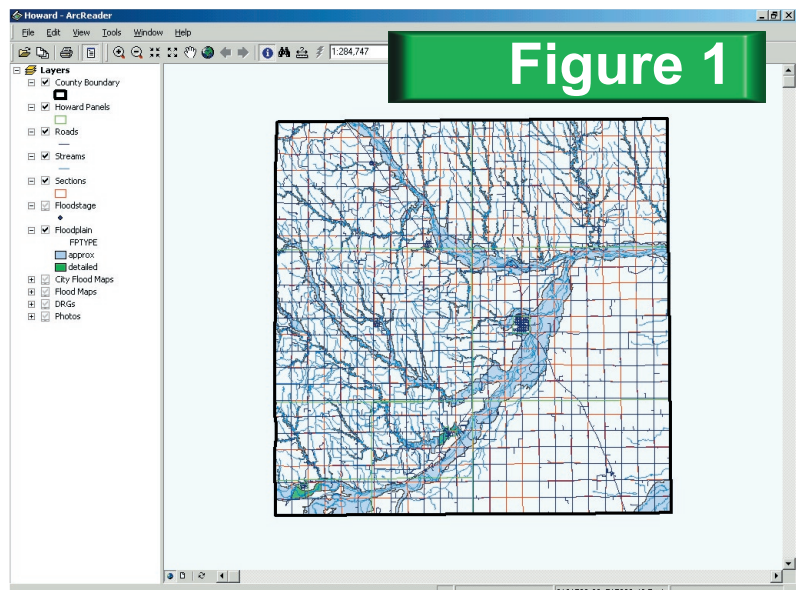
ArcReader®

During 2002, ESRI released the ArcPublisher® extension along with a free program called ArcReader®. ArcReader® works with ArcMap™ in a fashion analogous to that of Adobe Reader® and Adobe Acrobat®. ArcReader® allows users to view maps created in ArcMap 8.x™ in a read-only format. Maps are first created within ArcMap™ and then published using the ArcGIS™ Publisher® extension, which creates a published map file (.pmf file type) of the document. ArcReader® uses the .pmf files to view the maps created in ArcMap™ with limited functionality. ArcReader® is distributed by ESRI at no cost so that ArcGIS™ users can share the data that they compile and create with others who will benefit from this information.

NDNR has created ArcReader® Maps for each county in the state of Nebraska. The maps include a county boundary, roads, streams, sections, aerial photos, and the USGS topographic maps. In addition, the Flood Insurance Rate Maps (FIRMs) have been georeferenced and added where available. NDNR has mapped Approximate Zone A floodplains in 19 counties since 2000.

Where

available, this delineation is also included as a shapefile in the ArcReader® maps for these counties along with cross-section information that was used in the floodplain delineation process. The ArcReader® Map for Howard County, Nebraska is shown in **Figure 1**. These maps are provided on a CD to other government agencies for no charge and



to anyone else in exchange for a blank CD. This allows the floodplain information to be freely distributed, which promotes the active management of floodplains.

GEOREFERENCING EXISTING IMAGES

Image Data and Projected Data

The Federal Emergency Management Agency (FEMA) provides NDNR with FIRMs in both paper and electronic forms. Paper maps are scanned by the NDNR to a .tiff format. The scanned images do not have any associated projection. In order for the FIRMs to be displayed superimposed on aerial ortho photo maps, they need to be geographically referenced. This process, termed georeferencing (**See Table 1**), is accomplished by assigning control points to the original image and corresponding control points to a coverage in the desired projection. In this paper the term *Image* will refer to the FIRMs that are being georeferenced, and the term *Base Data* will refer to the data that is already in the desired projection. An example of a FIRM image is shown in **Figure 2**.

Table 1

Table 1- Georeferencing

- 1) Open ArcMap and add the projected data features and the image to be referenced.
- 2) Add the **Georeferencing** toolbar in the **Tools - Customize** menu, if necessary.
- 3) Identify similar points* on the projected data and the image.** (Control Points)
- 4) Click on the **Add Control Points** button on the **Georeferencing** toolbar.
- 5) Select the first control point on the image.
- 6) Find the corresponding point on the projected data.***
- 7) Select this control point on the projected data.
- 8) Complete steps 3 - 7 for all of the desired control points.
- 9) Check control points and their residual value in the Link Table on the Georeferencing toolbar.
- 10) Select the **Rectify** tab under the **Georeferencing** tool bar.
- 11) Navigate to find the desired location of the new file, name it and save it.
- 12) The file is saved as an entirely new file, preserving the original file. The new file contains the same image as the original only the new file will contain the coordinates assigned during the georeferencing process.

Tips

- * NDNR uses section lines and roads as control points.
- ** Choose 3 to 4 control points and try to orient them in the shape of an isosceles triangle or rectangle that encompasses a large portion of the image.
- *** The zoom in and out tool, transparency tool, and turning layers on and off tool can be utilized to find the corresponding point on the projected data. The **Add Control Points** button will need to be selected after using other tools. This will start the georeferencing process where it was left off.

Georeferencing begins in ArcMap™ with the addition of base data to a view that is already in the desired projection. When georeferencing the FIRMs, the NDNR typically uses the USGS topographic maps in a NAD 1983 Nebraska State Plane (feet) projection as base data. The USGS topographic map corresponding to the same location of the FIRM in **Figure 2**, is shown in **Figure 3**.

Next, the FIRMs that are to be assigned a projection are added to the data view. The **Georeferencing** toolbar must then be displayed by selecting it under the **Tools – Customize** menu. This is shown in **Figure 4**.

Control Points

Prior to georeferencing an image, corresponding control points on the base data and the image

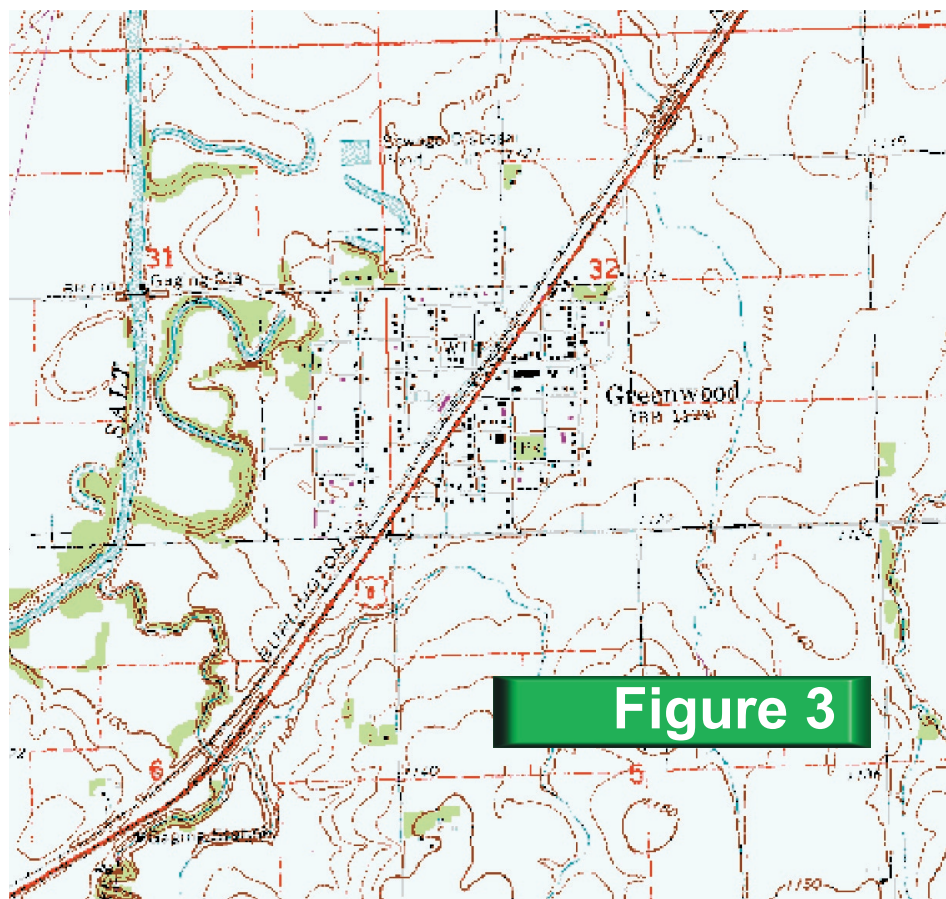


Figure 2



data must be identified. Section lines and road intersections are commonly used as control points for the georeferencing of the FIRMs. Three to four control points per image generally creates an adequate image reference. Less than three control points may not be sufficient to represent the image accurately with the base data in that projection. Because many FIRMs and other

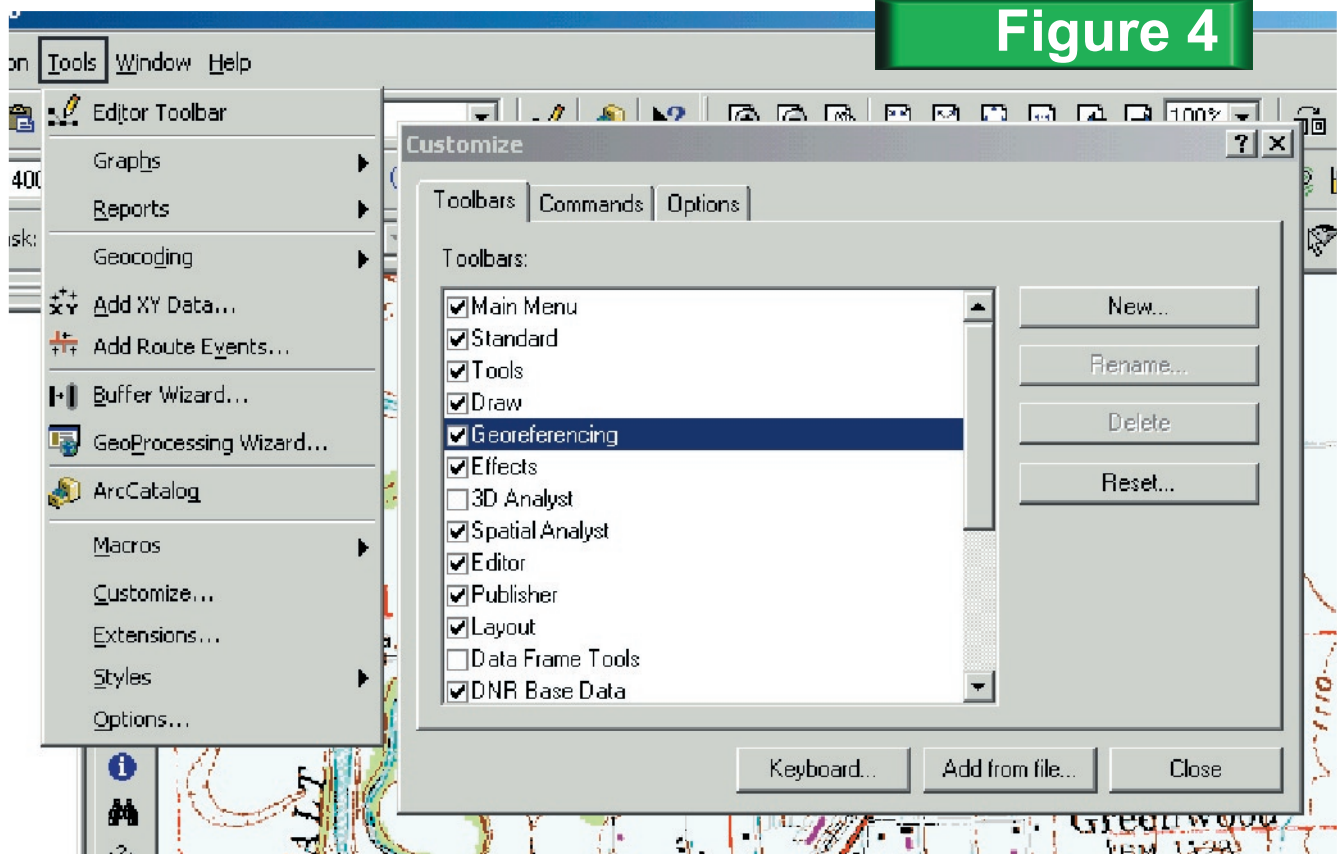
Figure 4

image data are not spatially accurate, more than four control points can create large distortions in the image. Very small differences in the image and the base data will cause the image to become skewed and distorted if the control points are not positioned in an acceptable manner. An example of this occurs when three control points are used that are nearly on the same line with each other.

The control points also must be spread out across the image so that the entire image will be properly referenced. Control points should be selected so that the scale of the referenced image will be similar to that of the image in both the x and y directions. In other words, the second control point should be nearly horizontal with the first control point so that the x-scale can be determined. The third control point should be placed on a line perpendicular to a line formed by the first two control points so that the scale in the y direction can be determined. If three control points are being used it is suggested that the control points are positioned to form of an isosceles triangle. If four control points are being used the suggestion would be to form a rectangle with the control points. The triangle or rectangle should be large enough to encompass most of the area of the image. These suggestions should ensure that the scale of the image will be accurate in both the x and y directions. Also, the scale will be applicable for the entire image because the control points are spread across the image.

Georeferencing

The first step in georeferencing is to make sure that the image file name to be georeferenced is selected. This is accomplished by selecting the image file name on the **Layer** dropdown list on the **Georeferencing** toolbar, as seen in **Figure 5**. After the image file has been selected and the placement of the control points has been chosen, the georeferencing of the image can begin by first clicking on the image at the first control point and then on the corresponding point in the base data. This is accomplished

Figure 5

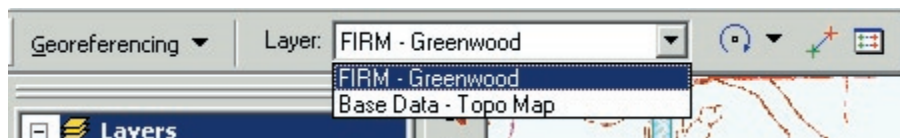
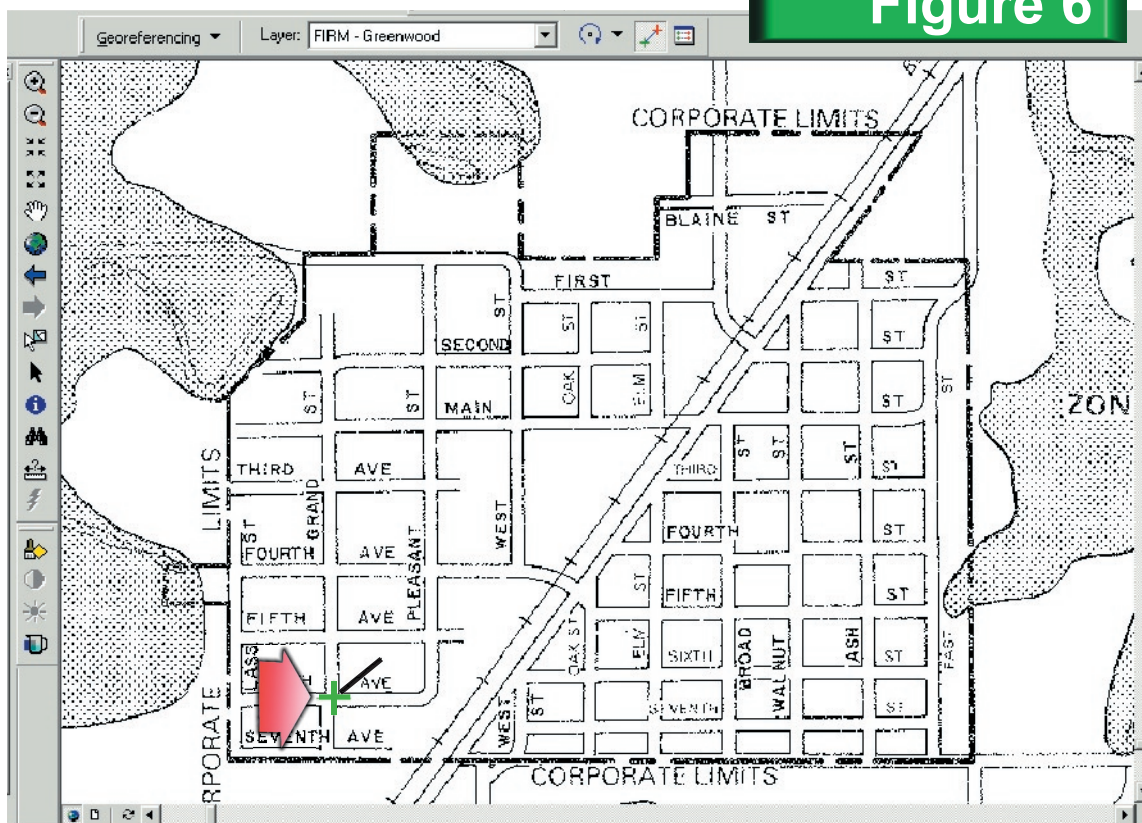


FIGURE A



by selecting the **Add Control Points** button (green and red plus marks connected by a blue line shown in **FIGURE A**) on the **Georeferencing** toolbar. Next, the first control point on the image to be referenced needs to be selected by clicking on it. A green plus mark will denote the control point that was selected and a line will follow this control point to the current position of the mouse. This

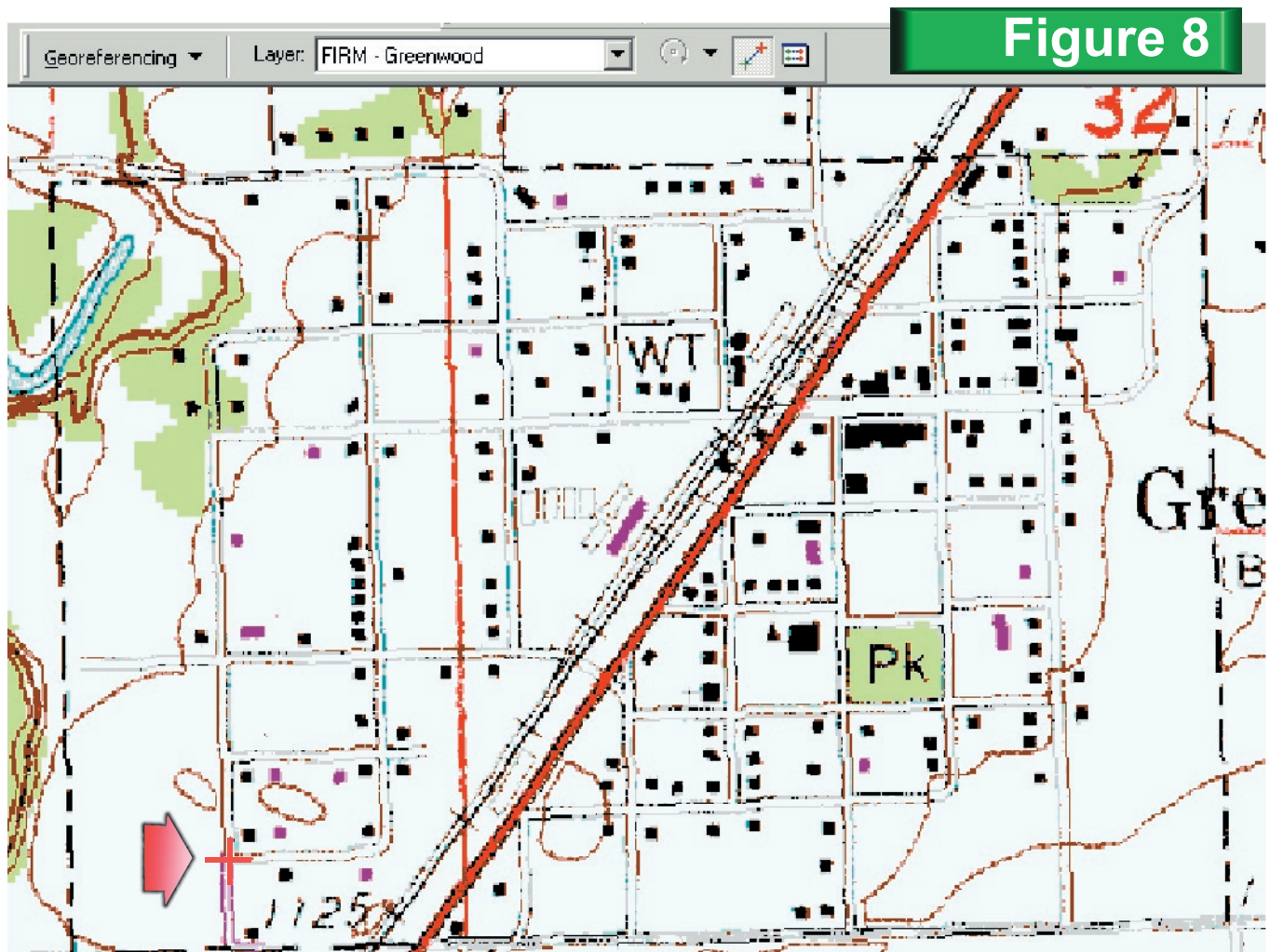
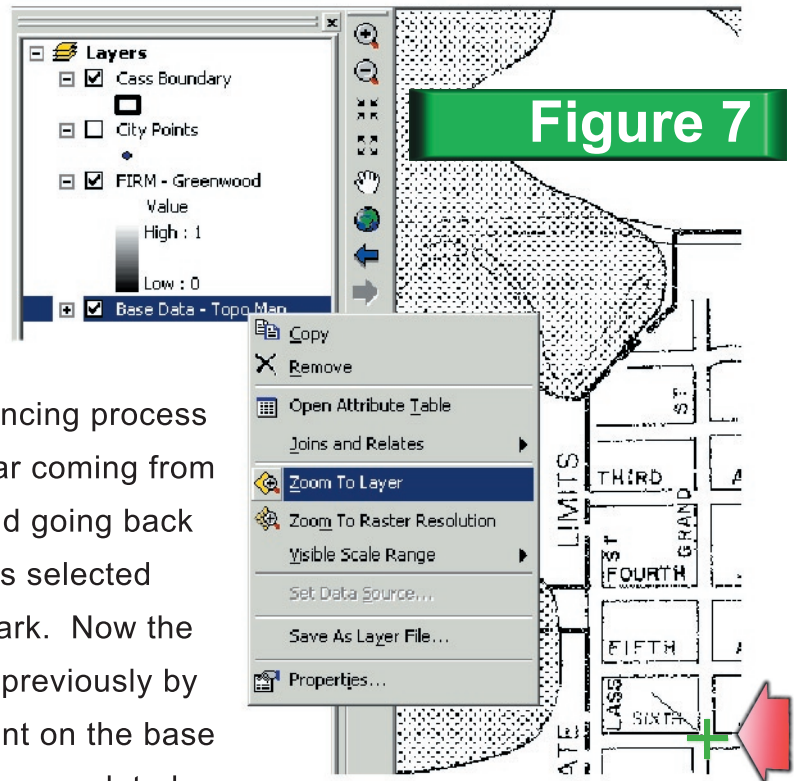
Figure 6



is shown in the lower left hand corner of **Figure 6**. The next click of the mouse is made on the corresponding control point on the already-projected base data. This will place the image control point onto the referenced control point and denote the referenced control point as a red

plus mark. (Generally the red plus mark will be directly on top of the green plus mark, so the green plus mark seems to disappear.) In between these functions the user can perform other functions such as zooming in or out, turning on or off layers or changing the transparency as necessary. The processes of zooming to the base data and selecting the control point on the base data are

shown in **Figure 7** and **Figure 8** respectively. Taking advantage of these functions allows the corresponding control points to be matched as closely as possible. Once these functions are completed the **Add Control Points** button must again be selected. This will pick up the georeferencing process where it was left off. A line should appear coming from the end of the current mouse position and going back to the control point on the image that was selected earlier and denoted by the green plus mark. Now the process can be completed as described previously by clicking on the corresponding control point on the base data image. This process should then be completed



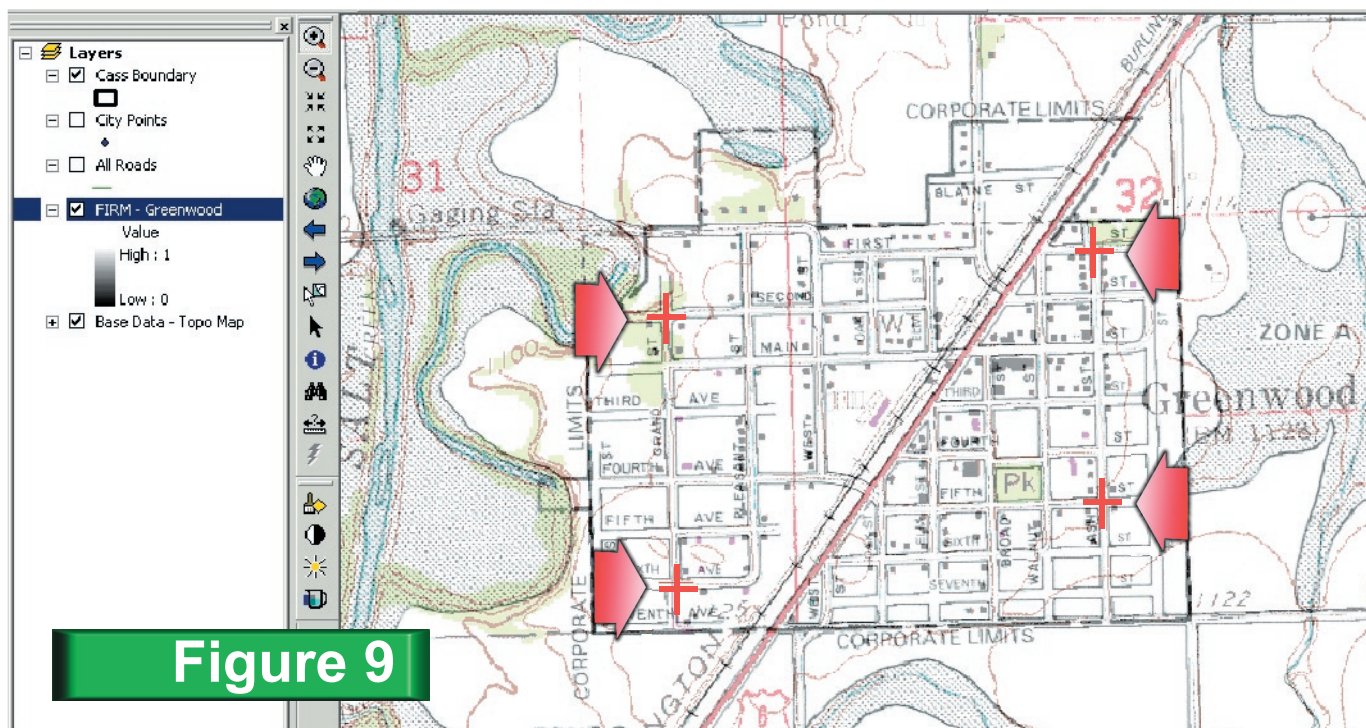


Figure 9

for all the desired control points selected. **Figure 9** shows this process completed using 4 control points. The FIRM image has its transparency set to 40% so that the topographic map can be seen beneath it.

Link Table and Residual

The progress of the georeferencing process is being tracked in the link table. The **Link Table**

FIGURE B

is located on the **Georeferencing** toolbar and is denoted by a picture of a table as shown in **FIGURE B**. The link table contains the current coordinate locations of each control point for both the projected data and the image. The last column contains the residual value. The residual value shows how much the image had to be skewed and distorted to fit the selected control points. The

Link Table

Link	X Source	Y Source	X Map	Y Map	Residual
1	8.095472	10.910130	2620832.029199	430063.863421	3.95269
2	8.065536	12.664011	2620758.350948	431838.281314	3.92804
3	10.895480	13.037695	2623610.278582	432283.299342	4.16349
4	10.917870	11.368907	2623663.028140	430606.020650	4.18814

Figure 10

Auto Adjust Transformation: ± 1 st Order Polynomial (Affine) Total RMS Error: 4.05982

Load... Save... OK

best references will have a lower residual. If the residual is too large, there is probably something wrong with the referencing (i.e. The user may have accidentally referenced one of the control points to the wrong place, or the projected data may be projected incorrectly). **Figure 10** shows the link table for the FIRM image that was georeferenced above.

Many times the image will not fit perfectly on the base data according to the selected control points. The control point on the image will actually be placed a small distance away from the control point on the base data to reduce the skewing and distortion of the image. A blue line will be drawn in between the green control point and the red control point. These blue lines are analogous to the residual in that longer blue lines result in poorer quality referencing. Links showing an unusually long line or high residual should be discarded.

The transparency of the top feature (generally the image) can be adjusted so that both features can be seen at the same time. This is an additional tool that the user can take advantage of to determine if the referencing is adequate.

Saving the Georeferenced Image

Finally, after all of the control points have been referenced with an acceptably low residual, the new placement of the image must be saved. This is done by selecting **Rectify** under the **Georeferencing** tab on the **Georeferencing** toolbar. This will bring up a box that will allow the user to select a file path and file name. This saves the image to a new file containing both the image and the spatial coordinates. In the future, this new file name will be the file that is used when the image is desired to be in the referenced coordinates.

CREATING ARCREADER® MAPS

Creating Data Structure

The first step in creating an ArcReader® .pmf file is to assemble the data that will be displayed in the map. The data files should be placed in a single folder in which all associated files will be kept along with the map document file. This will allow the .pmf file to utilize relative referencing of the other data files. The ArcPublisher® toolbar must then be displayed by selecting **Publisher** under the **Tools – Extensions** menu.

Displaying Data

Next, a map document containing the data files must be created in ArcMap™. **The data layers may be turned on or off in the ArcReader® map**, but their position in the table of contents is frozen. It is therefore essential that the data layers be positioned in the desired order prior to publishing the map. Additionally, the layer symbology, visible scale, transparency, and labeling must be set before publishing the ArcReader® map. **Figure 11** shows the completed Data View in ArcMap™ for the Howard County, Nebraska map created by NDNR. The layout view must also be created prior to publishing as well. The **View** menu contains the tabs that allow the user to switch between the **Data View** and **Layout View**. In the layout view, many

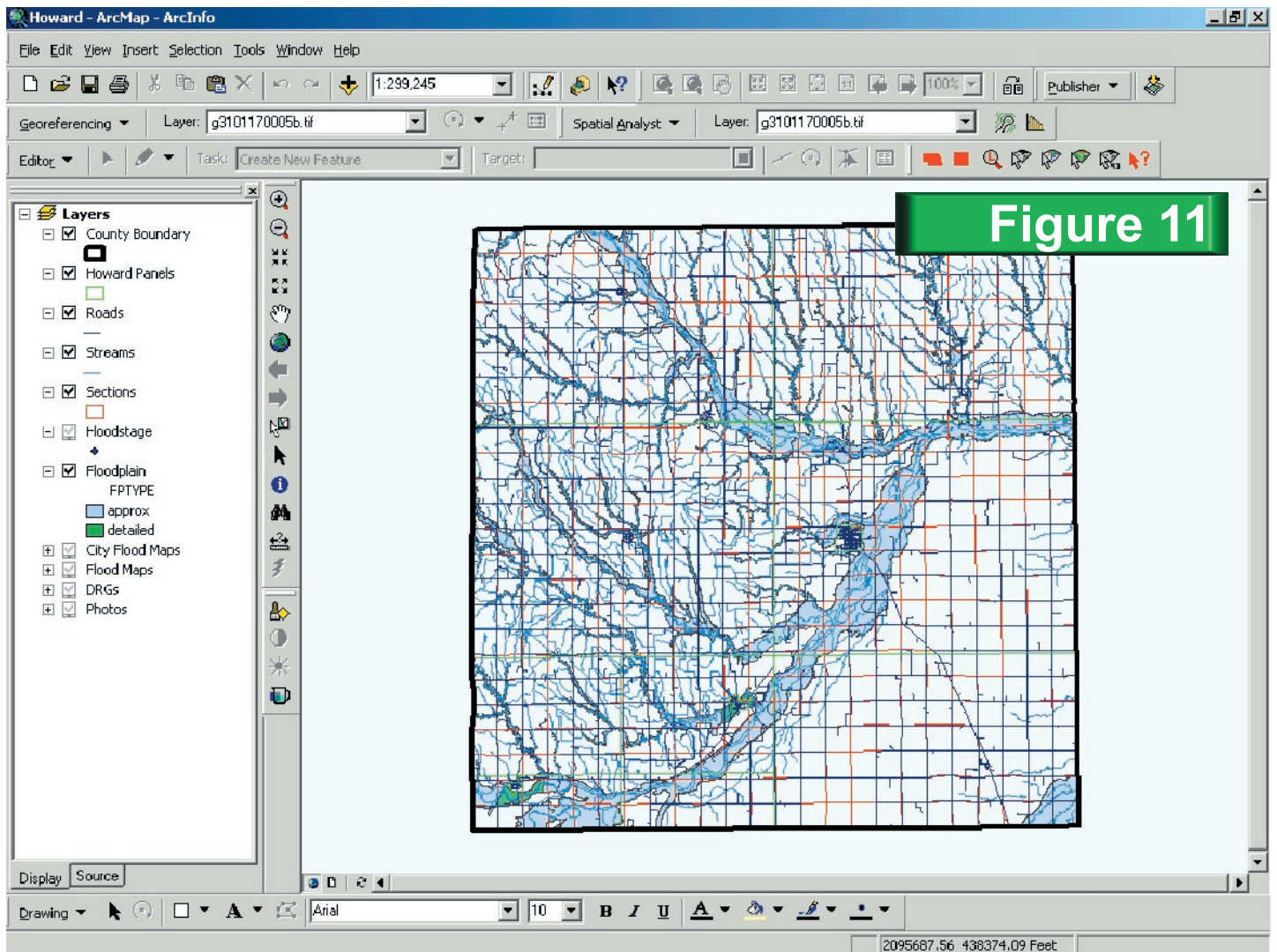


Figure 11

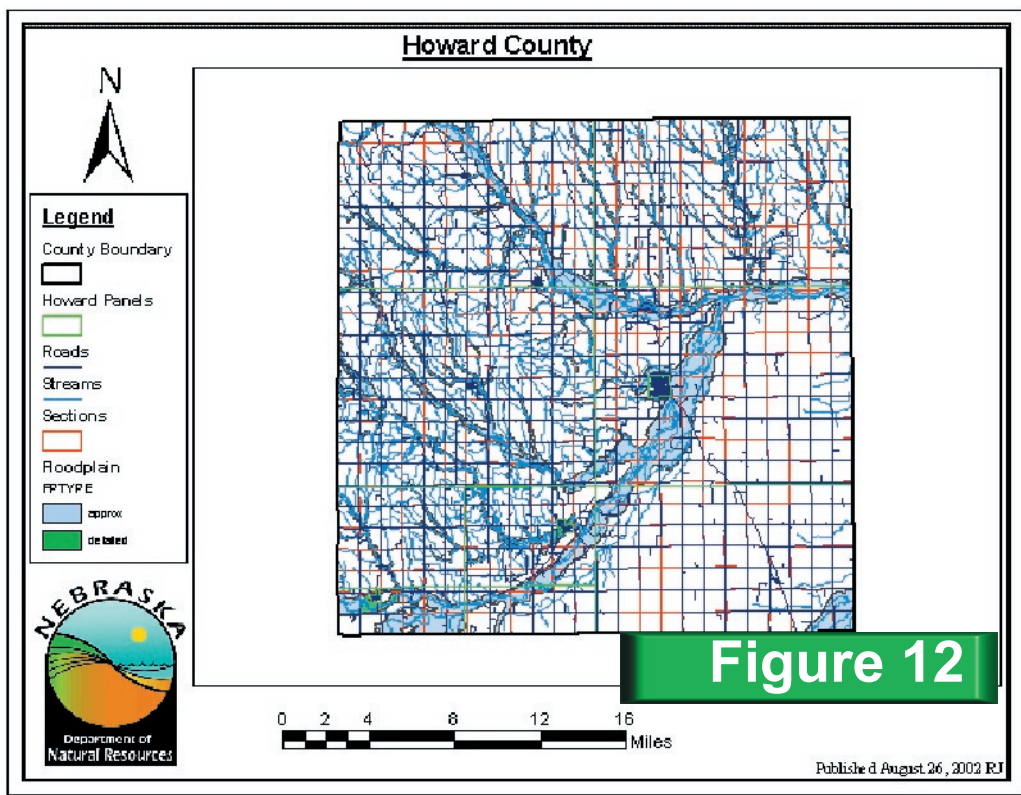
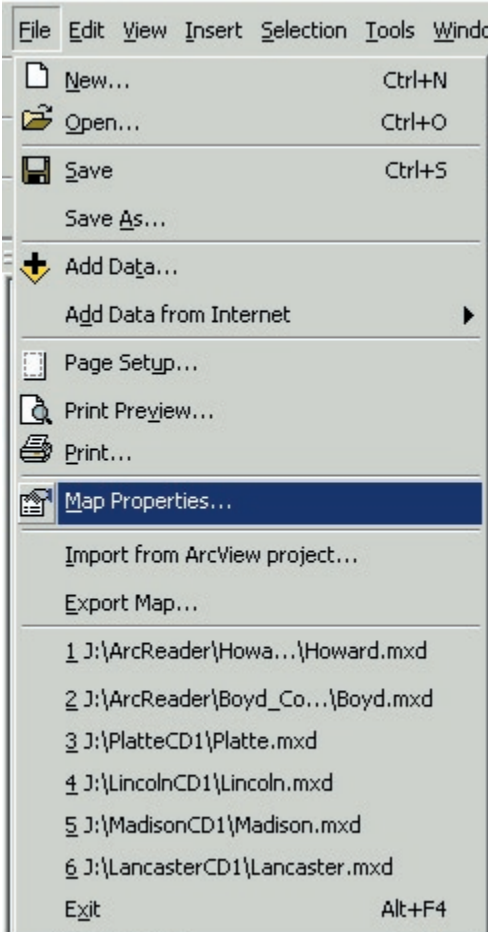


Figure 12

graphics are available to create a presentable printing document. The available graphics include a title box, scale bar, legend, north arrow, neatline, text, and pictures. The graphics and view window must be placed in the desired position prior to publishing as they are not allowed to be moved within the ArcReader® map. The Layout View created by NDNR for the ArcReader® maps is shown in **Figure 12**.

Figure 13a



Data Referencing

The published map file (.pmf) can relatively reference the shapefiles and image files in an ArcReader® map. This allows the maps and files to be put onto a CD or transferred to another computer. **Prior to the .pmf file being created, a map properties setting in ArcMap™ must be changed so that the file references are stored relatively.** This setting is located in the **Map Properties** dialog box under the **File** menu. The **Store Relative Path Names** option must then be selected under the **Data Source Options** tab. This is shown in **Figures 13a and 13b**. For this to work, all of the associated files, including the published map file, must have the same parent directory.

Functionality

After the ArcMap™ has all of the data added and its features appear in the desired manner, the functionality of the map needs to be chosen. The functionality within

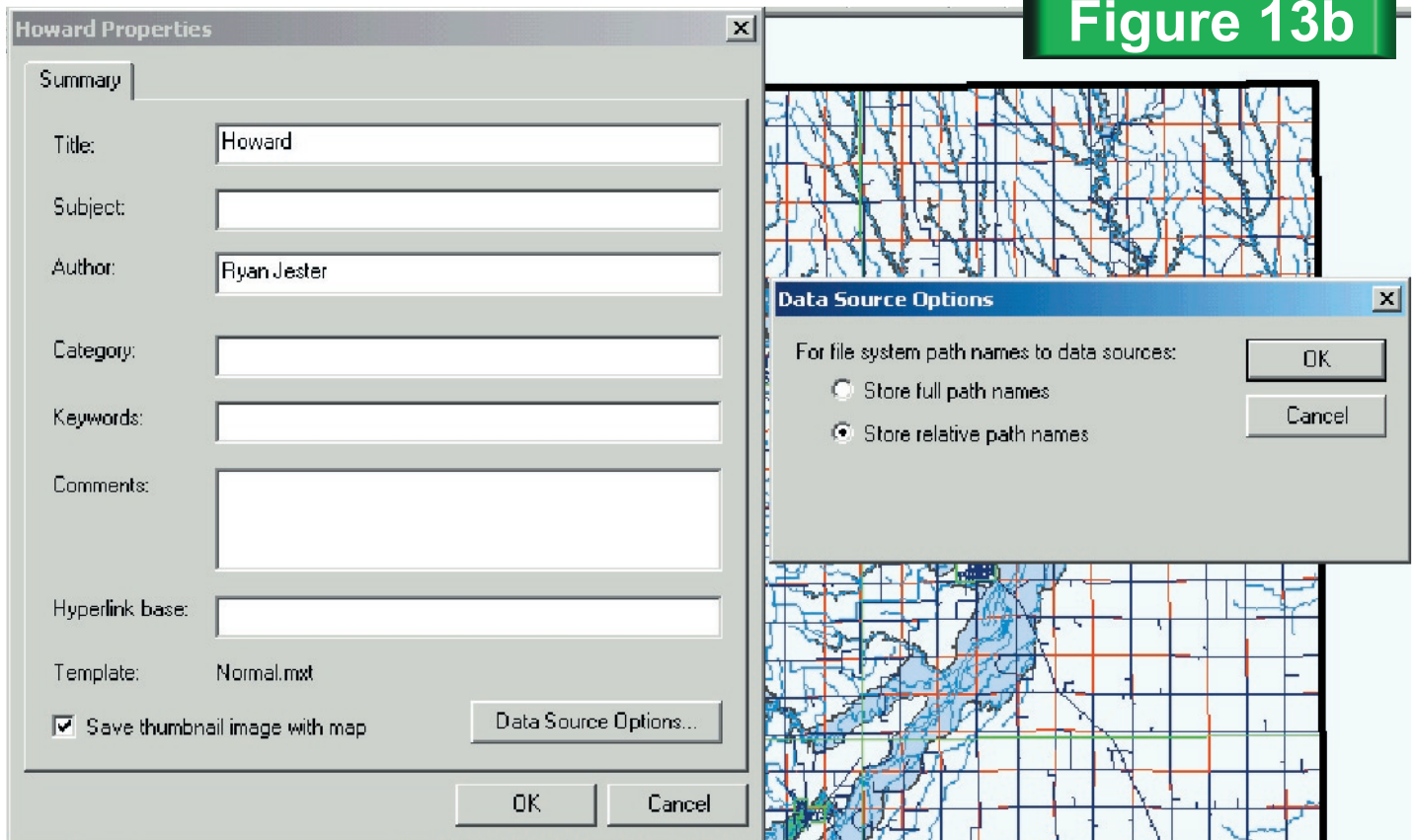


Figure 13b

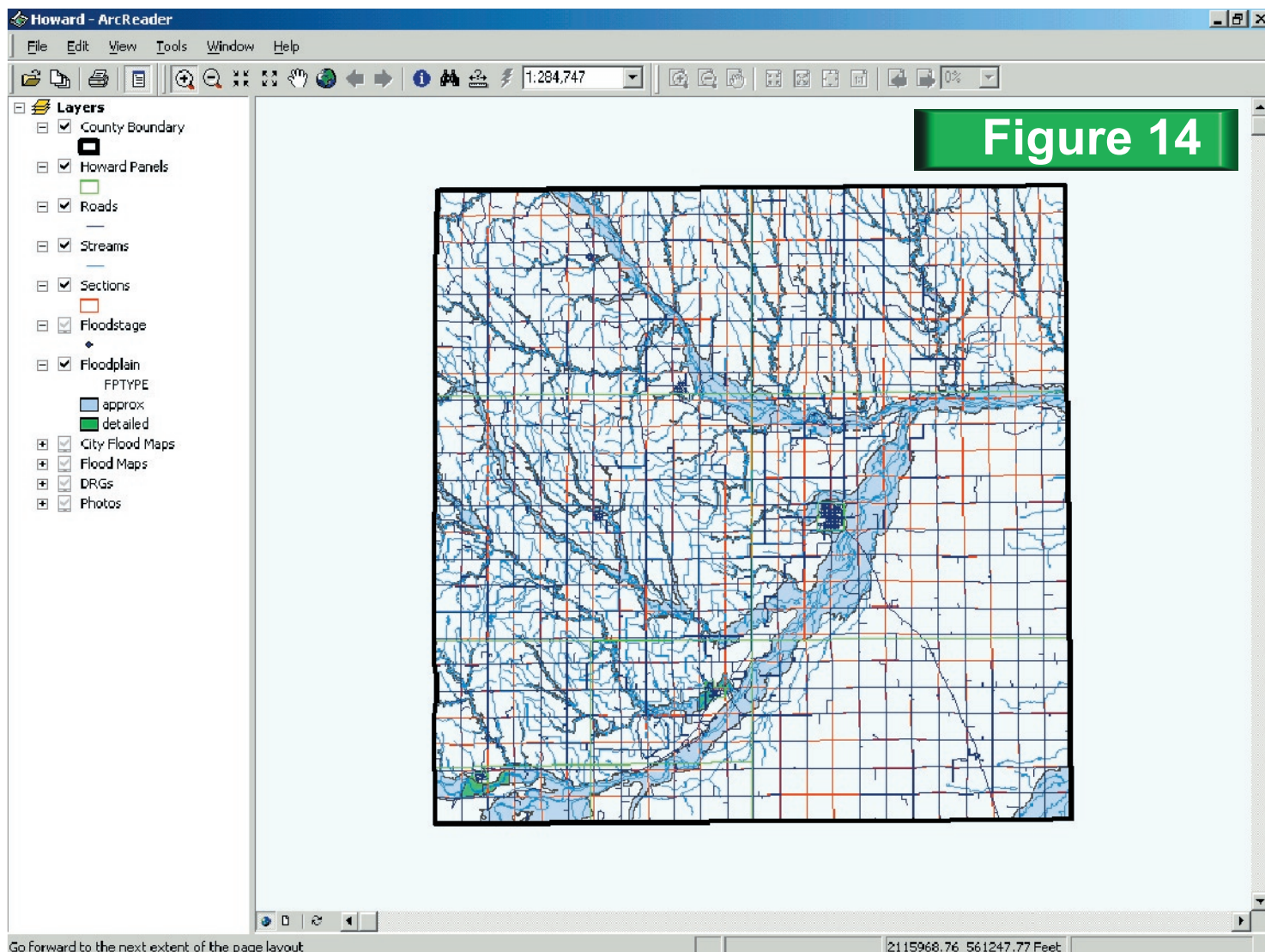
ArcReader® includes:

- Zoom in/out
- Pan
- Go to full extent
- Go to previous/next extent
- Identify Tool (multilayer)
- Switch between data view and layout view
- View spatial bookmarks
- Find Tool (for example, users may search for a particular stream name or section number)
- View and print pre-authored map layouts
- Open/Close published map files
- Shows recently opened maps
- Measure Tool
- Hyperlink Tool
- Magnifier Window

The creator of the map can disable some of these functions, allowing them to withhold parts of the data that contain sensitive information. Disabling of functions is accomplished by navigating to the **ArcPublisher** menu under **Settings**. The functionality features that can be disabled include:

- Find Tool
- Identify Tool
- Measure Tool
- Accessing Hyperlinks
- Printing
- Turning layers on and off in the Table of Contents
- Visibility of the Table of Contents

In addition, the layers that are shown in the map can be limited and the availability of the data view and layout view can be restricted. A password protection is also available to protect sensitive data. The maps that the NDNR has created include full functionality and no



restrictions. This allows full access to all available floodplain information. **Figure 14** shows the data view with full functionality in ArcReader® for the Howard County, Nebraska map.

Table 2 - Creation of ArcReader Maps

Table 2

- 1) Find and assemble the data that is desired to be on the map.
- 2) Make a new folder and copy all of the data to this folder.
- 3) Start a new ArcMap document and add all of the data.
- 4) Position the data in the table of contents in the desired order.
- 5) Adjust the visibility, layer symbology, transparency, visible scale, and labeling of all of the data features.
- 6) Create Layout View, including scale bar, title, legend etc. as desired.
- 7) Set relative referencing by selecting **Store Relative Path Names** under the **Data Source Options** tab located in the **Map Properties** dialog box under the **File** menu. This allows the data to be found by the map even if the folder is moved.
- 8) Add **ArcPublisher** toolbar in the **Tools - Extensions** menu, if necessary.
- 9) Set desired functionalities under the Settings button on the **ArcPublisher** toolbar.
- 10) Publish the map to the same folder by selecting **Publish Map** on the **ArcPublisher** toolbar and then navigating to the folder.
- 11) Distribute map (typically on CD).

Publishing the Map

Finally, the published map file must be created (See **Table 2**). This is accomplished by selecting the **Publish Map** tab under the **Publisher** menu. This will bring up a dialog box that will allow the user to select the name and location of the published map file. **The published map (.pmf file) location should be inside the same folder with all of the map's data.** The published map file is now created and can be shared with other users.

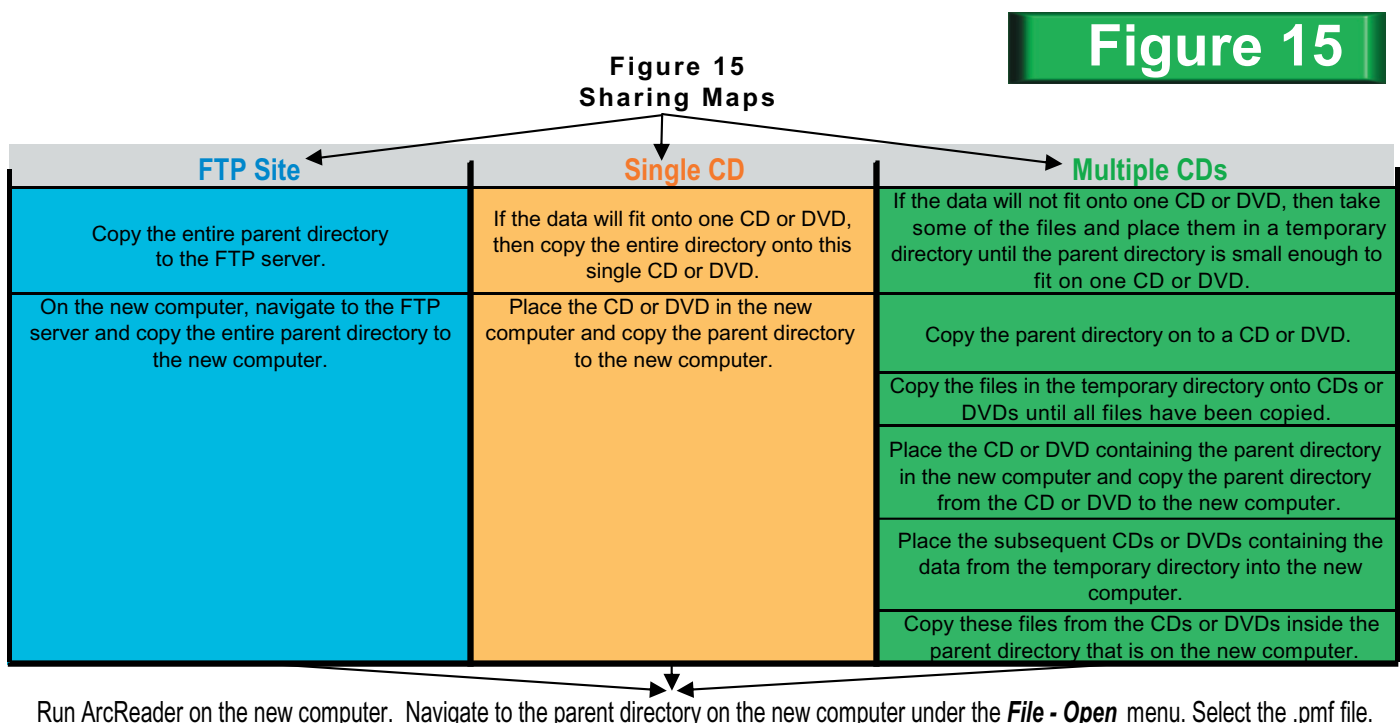
SHARING ARCREADER® MAPS

Obtaining ArcReader® Software

The first step in sharing ArcReader® maps is to install the ArcReader® program on the computer that the map is to be viewed on. ArcReader® can be downloaded at ESRI's web page, <http://www.esri.com/software/arcgis/arcreader/download.html>. A stand-alone CD is also available by calling ESRI at 1-800-447-9778 or by ordering from ESRI's web page, http://gis.esri.com/emails/arcreader_request.cfm. Once the software is obtained it must be installed on the computer.

Sharing the Maps

To share this data, the entire parent directory must be transferred to another computer. The ArcReader® map can then be viewed by opening the published map file. Complications can arise if a CD is transferring the data and the file size of the parent directory is too large for one CD, as is the case with many of the maps that have been created by the NDNR. In this situation, some of the files must be removed from the parent directory and put on a second CD and possibly a third or fourth.



When the data is moved to another computer the CD containing the parent directory must be loaded first. Files on the following CDs must then be put inside the parent directory on the new computer, which creates a file structure similar to that of the data on the original computer. As long as all of the associated files are within the parent directory, the relative referencing will work and the ArcReader® map will function correctly (See **Figure 15**). To view this map on the new computer, ArcReader® must be opened. Next, the .pmf file must be opened by selecting **Open** under the **File** tab and then navigating to the parent directory and selecting the .pmf file.

SUMMARY

The **Nebraska Department of Natural Resources** has created ArcReader® maps for **all 93 counties in Nebraska**. Data displayed in these maps include roads, streams, sections, county boundary, aerial photos, topographic maps, and FIRMs or the floodplain shapefile where available. The process of creating the ArcReader® maps begins with creating or obtaining the data. This process includes georeferencing the FIRMs so that they can be superimposed on the aerial photos and topographic maps. Next, the data is added to an ArcMap™ data view. Properties of the data are modified to achieve an aesthetically pleasing and functional map. Finally, the map is published to a .pmf file by using the ArcPublisher® extension. The .pmf file utilizes relative referencing so that the maps can be shared with other computers. Maps of each county and their associated data have been put onto CDs so that they can be distributed to those who desire the information. Copies of these maps can be obtained by calling NDNR at 402-471-2363 or by emailing fpintern1@dnr.state.ne.us.

